lation and a simple experimental model of a heavy-oil fractionator, and has been studied by numerous authors, especially as a case for model predictive control.

7 Needs for future work

The dynamic behavior for columns with varying pressure, non-constant molar flows (energy balance is needed) or non-ideal thermodynamics is not well understood. The same applies to interlinked column configurations and to the possible difference between trayed and packed columns. In terms of control there is a need for simple model structures which can be used for identification, and the possible improvements and problems of considering the control problem as a multivariable 5x5 problem are not well understood.

Appendix 1. Derivation of constant molar flows assumption

This derivation is included because no rigorous derivation of this common assumption was found in the recent literature (A rather complicated and different derivation where pressure variations are allowed is given by Roffel and Rijnsdorp, 1982, and an interesting discussion is found in King, 1971). Assume: 1) Reference state for energy is pure components as saturated liquids at a given reference pressure; 2) The column pressure is constant and equal to the reference pressure; 3) Negligible heat of mixing such that $h_{Li} = \Sigma_j x_{ij} c_{PLj}(T_i - T_{bpj})$ where T_{bpj} is the boiling point of pure component j at the reference pressure; 4) All components have the same value of the liquid molar heat capacity c_{PLj}; 5) The tray temperature T_i is the average of the component boiling points, $T_i = \Sigma_j x_i T_{bpj}$. These assumptions give $h_{Li} = 0$ and thus $dh_{Li}/dt = 0$ on all stages. The constant molar flow case is derived by assuming in addition that 6) the vapor phase is ideal and all components have the same heat of vaporization, $h_j^{vap} = h^{vap}$, where h_j^{vap} is the heat of vaporization of pure component j at the column pressure. Then $h_{Vi} = h^{vap} + \Sigma_j x_{ij} c_{PVj}(T_i - T_{bpj})$; 7) c_{PVj} is equal for all components such that the last term is zero (as for the liquid). Then we have on all stages $h_{Vi} = h^{vap}$, and the energy balance becomes $V_i = V_{i-1}$.

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